ENVIRONMENTAL PROTECTION SERVICE

ASSESSMENT OF CONTAMINATED SEDIMENT DISPOSAL WITHIN EAST BASIN OF FALSE CREEK

MARCH 1983

ENVIRONMENTAL PROTECTION SERVICE
ENVIRONMENT CANADA

B. C. PLACE/EXPO '86 DEVELOPMENT PROJECT:

ASSESSMENT OF CONTAMINATED SEDIMENT DISPOSAL WITHIN EAST BASIN OF FALSE CREEK

MARCH 1983

KERR WOOD LEIDAL ASSOCIATES LTD.
Consulting Engineers

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C O N T E N T S

ASSESSMENT OF CONTAMINATED SEDIMENT DISPOSAL
WITHIN EAST BASIN OF FALSE CREEK

L I S T O F F I G U R E S*

*follows Appendix A

ASSESSMENT OF CONTAMINATED SEDIMENT DISPOSAL WITHIN EAST BASIN OF FALSE CREEK

Synopsis

This preface has been included for the purpose of providing a capsule summary of the report contents. Highlights include:

1. Conceptual designs and cost estimates have been prepared for four options for contaminated sediment disposal within the East Basin of False Creek:

   - Option A involves a foreshore extension landfill in the southeast corner for 60,000 cu.m. (i.e. B. C. Place Phase 1 only).

   - Options B and C involve foreshore extension landfill sites on the south and north sides, respectively, for 350,000 cu.m. (i.e. Phase 1 plus Phase 2).

   - Option D involves filling the deepwater portions of the basin bottom.

2. Containment structures for the landfill options could be either sheet pile construction or gravel dykes (complete with an impervious core); with the costs for these two alternatives being comparable.

3. Direct construction costs for the foreshore extension landfill options are of the following orders-of-magnitude:

   - $2 1/2 million for Option A
   - $7 1/2 million for Option B
   - $6 million for Option C

Indirect costs such as land acquisition, lease termination, compensation for loss of foreshore access and/or water area, treatment of wastewater from sediment dewatering and dredging operations and other related costs are not included.

4. For the foreshore extension landfill options, major unknowns include the practicability of dewatering the dredged sediment slurry; and the acceptability (and cost, should pre-treatment be required) of discharging large volumes of water into the City of Vancouver sanitary sewer system.

5. The foreshore extension landfill options are incompatible with the City of Vancouver's development objectives for False Creek and the B. C. Place development concept plan, and are in violation of the Navigable Waters Protection Act.

6. Option D simply involves pumping the dredged sediment into the East Basin at a cost in the order of $2 1/4 million.

7. The critical depth for maintenance of marine access into the East Basin under low water conditions is 3 metres.

8. Based on the 3 metre criterion, the sub-tidal filling option can effectively only provide for about 2/3rds of the total sediment disposal requirement. (Complete disposal would require filling almost to the 2 metre contour.)

9. Some of the fine material, discharged to the East Basin from dredging operations, will stay in suspension and be conveyed to other areas of False Creek and possibly into English Bay*. It is doubtful that this would be environmentally approved or acceptable to the public.

*Source: 1981 AESL Report - Page 4 of Appendix A in Volume II

10. The May 1983 deadline for commencement of Expo '86 waterfront site preparation imposes an impossible time constraint for resolution of issues associated with the feasibility/acceptability of contaminated sediment disposal within the East Basin.

The objectives of this report are two-fold:

- to identify alternative design concepts that appear to be technically feasible for sediment disposal within False Creek.

- to identify non-technical considerations that may have a significant bearing on whether any or all of these concepts can in fact be implemented.

Based on the analysis presented herein, it appears that the non-technical considerations are of over-riding importance when assessing the acceptability of the concept of "on-site" disposal in the East Basin.

ASSESSMENT OF CONTAMINATED SEDIMENT DISPOSAL WITHIN EAST BASIN OF FALSE CREEK

1. INTRODUCTION

1.1 Background

Historically the False Creek area was the industrial core of Vancouver. A variety of industrial and domestic wastes from the area have over the years contaminated the marine sediments and upland soils to such an extent that concerns have been raised about their disposal. False Creek remains important to industry but more so to the region as a new city core including B. C. Place, Expo '86 and other developments.

B. C. Place is a Provincial Crown Corporation formed to consolidate ownership of False Creek north shore lands, provide a stadium, prepare and deliver a site for Expo '86, contribute to the improvement of public amenities and facilities in the area, provide housing and commercial areas, and through redevelopment, rehabilitate the environment of False Creek including improvement to the embayed marine waters along the north shore of False Creek. The City of Vancouver has had a long term commitment to improvement of the False Creek environment subject to the availability of resources.

Throughout the process of preparing plans for the B. C. Place Development Project and the early planning for Expo '86, the importance of the entire False Creek water body has been recognized as a visual amenity and even more importantly, for water contact and recreational activities.

Additionally, there is an expressed desire to restore entirely the marine environment of the basin in concert with the B. C. Place development, consistent with objectives of the City of Vancouver to restrict further contaminant discharge into False Creek.

B. C. Place plans to promote an early use of the water and waterfront by completing a seawalk and continuous waterfront walkway in time for the May 1986 opening of Expo '86, the World Class Transportation and Communications Fair to be held on its site.

A critical issue related to B. C. Place shoreline redevelopment activities involves the removal and disposal of 350,000 cu.m. (i.e. cubic metres) of contaminated marine sediment. Early resolution of the matter is critical because site preparation work is scheduled to commence in May 1983.

The figure of 350,000 cu.m. represents approximately half of the total volume of False Creek sediment to be excavated by B. C. Place. This material is contaminated with heavy metals (primarily cadmium, mercury and lead) and chlorinated hydrocarbons.

Four disposal alternatives as follows have been identified and assessed previously:

- on-site within the east basin of False Creek
- off-site to an existing sanitary landfill
- off-site to the Strait of Georgia (i.e. Point Grey Dumpsite)
- off-shore to the Pacific Ocean (i.e. 60km west of Vancouver Island)

The first alternative (i.e. utilizing the east basin of False Creek) has been selected by the Environmental Protection Service for further investigation.

The landfill alternative is not considered viable, while the Point Grey and off-shore alternatives are of concern because of the environmental implications with respect to the fisheries resource.

The concern with respect to the latter two alternatives relates to the fact that some of the sediments from False Creek do not meet the prescribed limits for ocean dumping as specified under the Canada Ocean Dumping Control Act (ODCA). Trace metal levels in the surface sediments are elevated - for example, cadmium in general is found between 2 and 5ppm (dry weight basis) as compared with an ODCA maximum permitted level of 0.6ppm.

1.2 Scope of Assignment

The B. C. Place foreshore development comprises two phases, with the 350,000 cu.m. volume of contaminated sediment being distributed approximately as follows:

- Phase 1 - 60,000 cu.m.
- Phase 2 - 290,000 cu.m.

Kerr Wood Leidal Associates Ltd. have been retained (as of March 18, 1983) by the Environmental Protection Service to identify and examine conceptual designs with respect to various options for disposal of the sediment within False Creek.

The basic options are two-fold:

- landfill to above high tide level in a confined area
- fill the basin bottom to below low tide level (in unconfined areas)

Variations of these options involve consideration of Phase 1 disposal only, and total (i.e. combined Phases 1 and 2) disposal.

The Terms of Reference issued by EPS specify the following tasks:

- select disposal sites and estimate extent of containment area requirements
- estimate dredging and conveyancing costs for discharge of sediments into containment sites
- provide cost estimates for containment structures
- provide an assessment of remedial measures required to overcome technical problems such as sediment dewatering and leachate control
- comment on possible social, political and aesthetic problems and sensitivities

A major constraint in preparing alternative design concepts is that barge access be maintained to existing industries.

1.3 Approach

The previously mentioned May target date for commencement of waterfront site preparation work has meant that completion of the assignment has had to be expedited in order to meet a March 31, 1983 deadline. It has therefore been necessary to quickly identify alternatives (i.e. disposal sites and/or layouts) that are obviously feasible on a technical basis, and that are relatively attractive. The

selection of foreshore extension landfill sites was, in part, based on observations noted in the course of a reconnaissance survey of the East Basin on March 21, 1983.

It has also been necessary to rely on past experience, as supplemented by verbal communications with other specialist consultants and major contractors familiar with conditions in False Creek, in order to assemble a reliable data base for design and cost estimating purposes.

1.4 References and Acknowledgements

In addition to information provided by EPS, the following documents have been used as reference sources in the preparation of this report:

- "North and East False Creek: Development Objectives for B. C. Place", prepared by City of Vancouver, May 1982.

- "False Creek Aquatic Improvement Study - Volumes I and II", prepared by Associated Engineering Services Ltd., December 1981.

In addition, the following individuals have assisted by providing current data on construction techniques and costs:

- Hugh Tucker, (Manager, Marine Division), Dillingham Construction Ltd. - unit prices for dredging and sheet pile construction.

- Oscar E. Henisen, P. Eng., Inquip Associates Ltd., Santa Barbara, California, U.S.A. - unit prices for soil-bentonite slurry trench cutoff construction.

We also wish to thank Mr. Rob Waters of B. C. Place for his assistance in providing mapping and background information on the project.

2. OPTIONS FOR DISPOSAL WITHIN THE EAST BASIN

2.1 Introduction

The purpose of this section is to describe four options which have been identified as being technically feasible for sediment disposal within False Creek; and these are:

- Option A - Landfill by foreshore extension on south side for B. C. Place Phase 1 contaminated sediments only (i.e. 60,000 cu.m.).

- Option B - Landfill by foreshore extension on south side for B. C. Place Phase 1 and 2 contaminated sediments (i.e. 350,000 cu.m.).

- Option C - Landfill by foreshore extension on north side for B. C. Place Phase 1 and 2 contaminated sediments.

- Option D - Subtidal filling of the basin bottom for B. C. Place Phase 1 and 2 contaminated sediments.

The plans corresponding to these options are presented as Figures 1 through 4, respectively.

Non-technical considerations that may have a significant bearing on whether any or all of these options can in fact be implemented are discussed in Section 3.

Containment Structures

Two alternatives have been considered for containing the landfill sites that would be developed under Options A, B and C; and these are:

- Sheet pile retainment structure complete with: reinforced concrete cap; and reinforced "hypalon" liner for leachate control.

- Dyke constructed from a well graded gravel (150mm minus) and armoured with rip-rap protection; and with a soil-bentonite slurry trench cutoff wall for leachate control.

It should be noted that in order for the sheet piling to withstand the high horizontal forces, the organic silts would be excavated and replaced with a gravel berm to approximately "low low water". The sheet piles would be driven through the centre of the berm and the outer face of the completed structure would be armoured with rip-rap.

It should also be noted that, for the dyking alternative, all organic material would be removed from below the dyke foundation prior to placing the gravel. (The depth of the organic layer varies between 1/2 and 2 metres.) It is assumed that the dyke would have 2:1 side slopes.

The conceptual design of the dyking alternative is based on limited soils information. It is assumed that the native silt material underlying the organic layer would be suitable for dyke foundations. This should be confirmed by means of a proper geotechnical investigation. (It should be noted that a soil failure reportedly occurred recently during filling of the east end of the basin. However, the failure was apparently attributable to the fact that material was simply end-dumped onto an unprepared base.)

Tidal Relationships

Figure 5 is presented in order to illustrate the relationship between Geodetic elevations and tide heights.

The datum for Figures 1 to 4 is "0 tide" (i.e. defined as the "lower low water" during a large tide). In other words, the contours shown on the plans are depths below "0 tide."

On Figure 5 it is also noted that the proposed finished design grade for the B. C. Place seawall is Geodetic El. 2.85 metres. This, then, established a top elevation for the foreshore extension landfill sites. (It is assumed that a covering layer of clay and soil would be placed over the dredged material and then seeded with grass; and that the thickness of this layer would be at least 600mm.)

2.2 Foreshore Extension Landfill on South Side

Phase 1 Disposal

Figure 1 illustrates how an existing bay in the southeast corner of False Creek could be utilized to contain the Phase 1 volume of 60,000 cu.m. Design parameters include:

- length of containment structure would be approximately 150 metres

- height of structure (from finished design grade to top of silt foundation) would typically be 10 metres

The foreshore extension landfill would result in a loss of water area in the order of 1 1/2 hectares. The impact on foreshore access for existing industries would be minimal.

A major cost factor associated with this option is extension of the existing City of Vancouver storm drain outfall. (The outfall is a 9 ft. wide by 11 ft. high box culvert.) This would involve pile supported construction techniques.

Phases 1 and 2 Disposal

Figure 2 illustrates how the Phase 1 disposal site would have to be extended west along the south shoreline of False Creek for an additional distance of about 250 metres in order to contain the total volume of 350,000 cu.m. Design parameters include:

- length of containment structure would be approximately 410 metres
- height of structure would typically be 11 metres

The landfill would extend some 150 to 200 metres out into False Creek and would result in a loss of water area in the order of 6 hectares. The impact on foreshore access for existing industries would be significant as an existing loadout facility would be eliminated. For this reason, it is suggested that an appropriate mitigation measure would be a foreshore access road (running the length of the landfill site) complete with a replacement loadout facility.

The existing storm drain outfall would also have to be extended for a distance of about 180 metres.

2.3 Foreshore Extension Landfill on North Side

Figure 3 has been developed in order to illustrate how a disposal site could be developed on the north side of False Creek in order to contain the total volume of 350,000 cu.m. Design parameters include:

- length of containment strucutre would be approximately 500 metres
- height of structure would vary between 8 metres and 15 metres

The foreshore landfill would typically extend some 150 metres out into False Creek and would result in a loss of water area in the order of 6 hectares. Access to the Lafarge concrete plant would be maintained.

2.4 Sub-Tidal Filling

Figure 4 illustrates how the deepwater portion of the basin bottom could be utilized for disposal of the dredged sediment. Key points to note include:

- the 60,000 cu.m. Phase 1 volume corresponds to filling from the 6 metre contour up to about the 4.5m contour

- the total available fill volume between the 6m and 3m contours is about 225,000 cu.m.

- the 350,000 cu.m. disposal requirement would require filling almost to the 2m contour

The critical depth for maintenance of marine access into the east basin under low water conditions is 3 metres (10 feet). The basis for this depth is as follows:

- it is anticipated that the basin will become a popular turnaround area for sailboats and tour craft

- in addition, there is the possibility of marina development

- draught requirements for sailboats are typically in the order of 1.80 to 2.10 metres (6 to 7 feet), and for a few larger sailing vessels up to 2.90 metres (9 feet)

- recent experience in a large private marina in Coal Harbour concluded that 2.5 metres is the absolute minimum acceptable depth, with 3.0 metres (i.e. 10 feet) being the preferred design depth

- 3 metres allows for anomalies in dredging and sufficient water for the larger keel boats

The significance of the foregoing is that it demonstrates that the sub-tidal disposal option is not entirely satisfactory because there is a conflict with marine navigation requirements. In short, this option can effectively only provide for about two-thirds of the sediment disposal requirements. In addition, it would require approval under the NWPA.

In order to minimize erosion and movement of the sediments seaward, this option includes a submerged gravel sill with 3 to 1 side slopes. The crest and downstream face of the sill would be armoured with "Armorflex" precast concrete mats preassembled and placed by a crane from a barge.

Finally, it should be noted that the existing low water depth of False Creek at various control sections is typically about 3 metres. Under the present conditions, loaded barges with draughts varying between 4 and 5 metres would be restricted access to the East Basin until the higher tides.

2.5 Cost Estimates

Cost estimates for the four options are detailed in Appendix A. For the three landfill options, construction costs are presented for both the dyke and sheet pile alternatives.

A summary of these estimates is as follows:

OPTION	DESCRIPTION	COST ESTIMATE
A	Foreshore landfill in southeast corner for Phase 1 disposal; and based on sheet piling	$2.6 million
A-1	Foreshore landfill in southeast corner; and based on dyking	2.5 million
B	Foreshore landfill along south side; and based on sheet piling	7.3 million
B-1	Foreshore landfill along south side; and based on dyking	7.6 million
C	Foreshore landfill along north side; and based on sheet piling	5.9 million
C-1	Foreshore landfill along north side; and based on dyking	6.0 million
D	Sub-tidal disposal	2.2 million

The estimates are based on 1983 Contractor prices, and include an allowance of 20 percent for engineering and contingencies. The estimates do not include the costs to purchase land, terminate leases, provide compensation for loss of foreshore access and/or water area, treatment of wastewater from the dewatering of sediments and/or dredging operations and costs to modify the development plans of B. C. Place and Expo' 86.

Specific points to note with respect to the cost estimates include:

- It has been assumed that dredging of the sediments would be permitted on all flood tides for a minimum period of 7 hours. If dredging is restricted to daylight hours, possibly as a result of the City of Vancouver's noise bylaw, the unit cost for dredging would double. This would add at least 1.3 million dollars to Options B to D, inclusive.

- For Options A, B and C, it has been assumed the surplus water from the dredging operations will decant directly into the East Basin of False Creek after a short retention period.

- There is insufficient geotechnical information to determine if the contaminated sediments could be readily dewatered. However, the cost of a system utilizing sand packed well points has been included in the estimates to cover this aspect of the work. This system has been used to dewater other fine grained soils; however, additional geotechnical data and/or infield testing would be required to verify its application to this project.

It has also been assumed that the contaminated water from the dewatering system can be discharged directly to the sanitary sewer for initial dilution and final discharge to the Regional wastewater treatment plant. The Greater Vancouver Regional District and the City of Vancouver may not accept the contaminated water in the sewer without pretreatment.

- There is a possibility that old mill wastes will be encountered and that these fiberous materials could reduce the effectiveness of any proposed dewatering system. No allowance has been made in the estimate for this possibility, as information is presently not available on these materials.

- The estimates do <u>not</u> include the costs of purchasing private land, terminating leasehold properties or compensation for loss of foreshore access.

- Environmental monitoring and assessment costs have not been included in the estimates.

- For Option D (See Section 2.4 Subtidal Deposition), there has been no allowance made for covering the contaminated silts after deposition. It is considered doubtful that any simple covering of sand and/or gravel would be effective against boat propeller wash with only a minimum water depth of 2 metres.

- Costs were derived, in part, by consultation with contractors specializing in each phase of the work and from recent cost data on similar projects.

- All estimates for dykes were based on importing 150mm minus well graded processed gravel. The material would be brought in by barges and placed sub-aqueously.

- The disposal areas for all options would effect the proposed development plans for B. C. Place and Expo '86. In addition, the City of Vancouver's development objectives which were adopted by City Council, would not be met. There is no allowance in the cost estimates for redesign of the proposed developments or compensation costs to the City of Vancouver associated with excavating new areas to offset the loss of water area.

3. CONSTRAINTS RESTRICTING UTILIZATION OF EAST BASIN

3.1 Introduction

The primary objective of this report is to provide alternative concepts and engineering details with respect to what is likely to be involved in developing sediment disposal sites within the East Basin. A secondary objective, however, is to identify "external" constraints that may restrict utilization of the basin for sediment disposal purposes; and which may be of over-riding importance when a final assessment of the acceptability of the options presented in Section 2 is completed.

The purpose of this section, then, is to identify and briefly discuss (in general terms) the aforementioned constraints.

3.2 City of Vancouver

Preservation of Water Surface Area

The City of Vancouver considers False Creek to be an irreplaceable water and open space resource within the core area of the City. For this reason, Council has stated its' position as follows with respect to development objectives:

> "Do no reduce area of water body and maintain sense of large expanse of water, especially at east end."

Consideration will be given, however, to infilling at a few strategic locations if deemed appropriate to enhance

the public use of the waterfront. This would be contingent, however, on maintaining an equal balance of cut and fill.

Options A, B and C are in conflict with the above objective, as the foreshore landfills proposed under all three would result in a significant reduction of the water body.

A second development objective of the City is that water quality be improved through a pollution abatement program. In that regard, then, the City may consider Option D to be in conflict because the filling operation would result in a concentration of contaminated sediment in the east basin.

Compliance with Noise Bylaw

A factor that may significantly affect the cost of a dredging operation is the City's noise bylaw. If dredging is restricted to the daylight hours because of the proximity of the existing False Creek residential development, then this would permit only one 7-hour shift per day.

Extension of Storm Drain

The City has a major storm drain that discharges into False Creek at the foot of Terminal Avenue. Extension of the outfall beyond the limits of the proposed landfill accounts for approximately 40 percent and 25 percent of the total cost of Option A and Option B, respectively.

3.3 Navigable Waters Protection Act

The Navigable Waters Protection Act (NWPA) imposes two restrictions as follows:

- no encroachment on harbour headlines
- no reduction in depth of navigable waters

Option A involves filling of a small bay that does not encroach on the harbour headlines. Therefore, there would be no conflict with the NWPA.

Both Options B and C involve filling beyond the limits of the existing headlines for False Creek. Therefore, both would be in conflict with the NWPA.

Under Option D, if the total quantity of 350,000 cu.m. of contaminated sediments were dispoed subaqueously, it would effectively eliminate the East Basin as a navigable waterway under low tide conditions. Therefore, it too would be in conflict with the NWPA.

3.4 B. C. Place Development Concept

The development plan provided by B. C. Place indicates provision for a marina in the small bay located in the southeast corner of the East Basin. Filling of the bay under either Option A or Option B eliminates the marina possibility.

The filling of the north side under Option C is incompatible with the waterfront development concept proposed by B. C. Place.

Option D is generally compatible with the waterfront development concept. However, filling the basin bottom to the 2m depth would significantly limit water contact and recreational activities (i.e. boating).

3.5 Marine Access to Existing Industries

South Side

The impact on existing industries, in terms of foreshore access, was discussed previously in Section 2.2, wherein it was noted that one small ramp would be eliminated under Option B. This could, however, be relatively easily replaced.

The impact of Options A and D is minor. Although the existing plant (that manufactures treated board) in the southeast corner technically has foreshore access, in reality this access is not utilized.

North Side

Industry is being removed from the north side in conjunction with development of B. C. Place. The existing Lafarge concrete plant will reportedly remain, however, for at least another 20 years. It is therefore important that barge access be maintained to the plant.

The one option which has a definite impact on barge access is Option D since this involves filling in of the basin bottom.

The draught of barges used by Lafarge range between 4 and 5 metres. Filling of the basin to the proposed 3 metre depth (or to the 2 metre depth for complete disposal of

the 350,000 cu.m. of sediment) totally eliminates leaving loaded barges in the basin over a tide change.

The Lafarge wharf is the only existing marine facility (other than that for Bay Lumber which is already scheduled for removal as part of the stadium development) on the north side. Under Option C, filling of the foreshore could be deemed to be eliminating "potential" waterfront access. However, access could be re-established (if required) by constructing a roadway on a pile foundation.

3.6 Sediment Dewatering and Foreshore Landfill Surfacing

Based on experience on another project, saturated silts and clays were stripped from a construction site and simply pushed into a disposal area. After 10 years the material located below the surface crust would not support equipment and would flow by gravity when the surface crust was disturbed.

In this regard, then, it is anticipated that the contaminated silts from False Creek would require dewatering. For estimating purposes, a well point system consisting of closely spaced sand packed well points is proposed. The well points would be placed under vacuum and the surrounding material slowly dewatered. Additional geotechnical investigations are required, however, to confirm the feasibility of this system.

It has been assumed that the effluent from the dewatering system can be discharged directly to the sanitary sewer. However, the Greater Vancouver Regional District and the City of Vancouver may require pretreatment before discharge to the sewers is permitted.

3.7 Foundation Conditions

Based on discussions with geotechnical engineers working in the False Creek Area, additional work must be carried out to determine whether the native silts can support fill and dyke structures when subjected to seismic loading. This would have serious cost implications if all fill structures had to be founded on the underlying glacial tills.

3.8 Dredging Operations

Previously, reference has been made to the City of Vancouver noise bylaw and its significance with respect to dredging costs (should the dredging operation be restricted to one shift). Another consideration is the possible environmental impact associated with the discharge of the sediment slurry at the landfill sites.

Some of the material will be in suspension, and it will take several days for clay and colloidal material to settle out. Initially, some material will be carried out into False Creek.

It is not feasible to construct settling facilities to provide the retention time necessary to clarify the decant water from dredging operations. Even with the addition of coagulants, such as are used in mining settling ponds, it is doubtful that clarified water would be released.

3.9 Property Acquisition

The matter of property acquisition as well as the termination of foreshore leases, in order to proceed with landfill development, is beyond the scope of this assignment. It should be noted, however, that it is a matter that could result in project delays because of the time required to complete negotiations with property owners (including the City of Vancouver).

3.10 Timing

The latest start on waterfront site preparation for Phase I (specifically, dredging and seawall construction) has been stated as early May 1983. This leaves approximately one month to resolve the issues and constraints identified in this report in order to utilize the East Basin for sediment disposal. The time available is too short.

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ASSESSMENT OF CONTAMINATED SEDIMENT DISPOSAL WITHIN EAST BASIN OF FALSE CREEK

APPENDIX A - CONSTRUCTION COST ESTIMATES*

* Indirect Costs such as land acquisition, lease termination, compensation for loss of foreshore access and/or water area; treatment of wastewater from sediment dewatering and dreding operations and other related costs are not included.

TABLE 1: CONSTRUCTION COST ESTIMATE FOR OPTION A

FORESHORE LANDFILL ON SOUTH SIDE OF EAST BASIN FOR PHASE 1 DISPOSAL ONLY (i.e. 60,000 cu.m.); BASED ON SHEET PILE CONTAINMENT STRUCTURE

ITEM	DESCRIPTION	ESTIMATE
1.	Suction dredging and conveyance of silts to the East Basin (60,000 cu.m. @$3.75 per cu.m.; plus $150,000 for mobilization/demobilization)	$375,000
2.	Sheet pile retainment structure c/w horizontal gravel support berm, rip-rap toe protection, and concrete cap (150 metres @$5,300/metre)	795,000
3.	Reinforced Hypalon Liner for sheet pile wall (to prevent leaching of contaminants) (1950 sq.m. @$22 per sq.m.)	43,000
4.	Extension of City of Vancouver Stormdrain (approx. size 3 x 3.5 metres) constructed on piles (100 metres @$8,300/metre)	830,000
5.	Partial dewatering of contaminated silts utilizing sand packed low capacity well points (assumed water discharged to sanitary sewer) (1.40 hectares @$40,000/ha)	56,000
6.	Impervious cover, soil and grass over completed disposal area (1.40 hectares $60,000/ha)	84,000
	Direct Construction Costs	$2,183,000
	Contingencies and Engineering @20%	437,000
	TOTAL CONSTRUCTION COST	$2,620,000*

*say 2.6 million

TABLE 2: CONSTRUCTION COST ESTIMATE FOR OPTION A-1
FORESHORE LANDFILL ON SOUTH SIDE OF EAST BASIN FOR PHASE 1 DISPOSAL ONLY (i.e. 60,000 cu.m.); BASED ON DYKING

ITEM	DESCRIPTION	ESTIMATE
1.	Suction dredging and conveyance of silts to the East Basin (60,000 cu.m. @$3.75 per cu.m.; plus $150,000 for mobilization/demobilization)	$375,000
2.	Construction of gravel retainment dyke and removal of organic silts for the foundation, c/w rip-rap armour facing	
	• Dyke including dredging of foundation (40,000 cu.m. @$15.00 per cu.m.)	600,000
	• Rock Armour (225 cu.m. @$22.00 per cu.m.)	50,000
3.	Soil Bentonite slurry trench cutoff for gravel dyke (1500 sq.m. @$60 per sq.m.)	90,000
4.	Extension of City of Vancouver Stormdrain (approx. size 3 x 3.5 metres) constructed on piles (180 metres @$8,300/metre)	830,000
5.	Partial dewatering of contaminated silts utilizing sand packed low capacity well points (assumed water discharged to sanitary sewer) (1.40 hectares @$40,000/ha)	56,000
6.	Impervious cover, soil and grass over completed disposal area (1.40 hectares $60,000/ha)	84,000
	Direct Construction Costs	$2,085,000
	Contingencies and Engineering @20%	417,000
	TOTAL CONSTRUCTION COST	$2,502,000*

*say 2.5 million

TABLE 3: CONSTRUCTION COST ESTIMATE FOR OPTION B
FORESHORE LANDFILL ON SOUTH SIDE OF EAST BASIN FOR TOTAL B. C. PLACE SEDIMENT DISPOSAL (i.e.350,000 cu.m.); BASED ON SHEET PILE CONTAINMENT STRUCTURE

ITEM	DESCRIPTION	ESTIMATE
1.	Suction dredging and conveyance of silts to the East Basin (350,000 cu.m. @$3.75 per cu.m.; plus $150,000 for mobilization/demobilization)	$1,460,000
2.	Sheet pile retainment structure c/w horizontal gravel support berm, rip-rap toe protection and concrete cap (410 metres @$5,300/metre)	2,173,000
3.	Reinforced Hypalon Liner for sheet pile wall (to prevent leaching of contaminants) (5740 sq.m. @$22 per sq.m.)	126,000
4.	Extension of City of Vancouver Stormdrain (approx. size 3 x 3.5 metres) constructed on piles (180 metres @$9,000/metre)	1,530,000
5.	Partial dewatering of contaminated silts utilizing sand packed low capacity well points (assumed water discharged to sanitary sewer) (5.80 hectares @$40,000/ha)	232,000
6.	Impervious cover, soil and grass over completed disposal area (5.80 hectares $60,000/ha)	348,000
7.	Construction of frontage road and installation of one load out facility* to provide water access to industires cutoff by the disposal area	
	• 210 metres of gravel road @$300/metre	63,000
	• Load out ramp	110,000
	Direct Construction Costs	$6,042,000
	Contingencies and Engineering @20%	1,208,000
	TOTAL CONSTRUCTION COST	$7,250,000**

**say 7.3 million

*Replaces existing small load out ramp

TABLE 4: CONSTRUCTION COST ESTIMATE FOR OPTION B-1
FORESHORE LANDFILL ON SOUTH SIDE OF EAST BASIN FOR TOTAL B. C. PLACE SEDIMENT DISPOSAL (i.e.350,000 cu.m.); BASED ON DYKING

ITEM	DESCRIPTION	ESTIMATE
1.	Suction dredging and conveyance of silts to the East Basin (350,000 cu.m. @$3.75 per cu.m.; plus $150,000 for mobilization/demobilization)	$1,460,000
2.	Construction of gravel retainment dyke and removal of organic silts for the foundation c/w rip-rap armour facing	
	• Dyke, including dredging of foundation (144,000 cu.m. @$15.00 per cu.m.)	2,160,000
	• Rock Armour (6800 cu.m. @$22.00 per cu.m.)	150,000
3.	Soil Bentonite slurry trench cutoff for gravel dyke (4550 sq.m. @$60 per sq.m.)	273,000
4.	Extension of City of Vancouver Stormdrain (approx. size 3 x 3.5 metres) constructed on piles (180 metres @$9,000/metre)	1,530,000
5.	Partial dewatering of contaminated silts utilizing sand packed low capacity well points (assumed water discharged to sanitary sewer) (5.80 hectares @$40,000/ha)	232,000
6.	Impervious cover, soil and grass over completed disposal area (5.80 hectares $60,000/ha)	348,000
7.	Construction of frontage road and installation of one load out facility* to provide water access to industries cutoff by the disposal area	
	• 210 metres of gravel road @$300/metre	63,000
	• Load out ramp	110,000
	Direct Construction Costs	$6,326,000
	Contingencies and Engineering @20%	1,265,000
	TOTAL CONSTRUCTION COST	$7,591,000**

**say 7.6 million

*Replaces existing small load out ramp

TABLE 5: CONSTRUCTION COST ESTIMATE FOR OPTION C
FORESHORE LANDFILL ON SOUTH SIDE OF EAST BASIN FOR TOTAL B. C. PLACE SEDIMENT DISPOSAL (i.e.350,000 cu.m.); BASED ON SHEET PILE CONTAINMENT STRUCTURE

ITEM	DESCRIPTION	ESTIMATE
1.	Suction dredging and conveyance of silts to the East Basin (350,000 cu.m. @$3.75 per cu.m.; plus $150,000 for mobilization/demobilization)	$1,460,000
2.	Sheet pile retainment structure c/w horizontal gravel support berm, rip-rap toe protection and concrete cap (500 metres @$5,300/metre)	2,650,000
3.	Reinforced Hypalon Liner for sheet pile wall (to prevent leaching of contaminants) (6750 sq.m. @$22 per sq.m.)	149,000
4.	Partial dewatering of contaminated silts utilizing sand packed low capacity well points (assumed water discharged to sanitary sewer) (6.25 hectares @$40,000/ha)	250,000
5.	Impervious cover, soil and grass over completed disposal area (6.25 hectares $60,000/ha)	375,000
	Direct Construction Costs	$4,884,000
	Contingencies and Engineering @20%	977,000
	TOTAL CONSTRUCTION COST	$5,861,000*

*say 5.9 million

TABLE 6: CONSTRUCTION COST ESTIMATE FOR OPTION C-1
FORESHORE LANDFILL ON SOUTH SIDE OF EAST BASIN FOR TOTAL B. C. PLACE SEDIMENT DISPOSAL (i.e.350,000 cu.m.); BASED ON DYKING

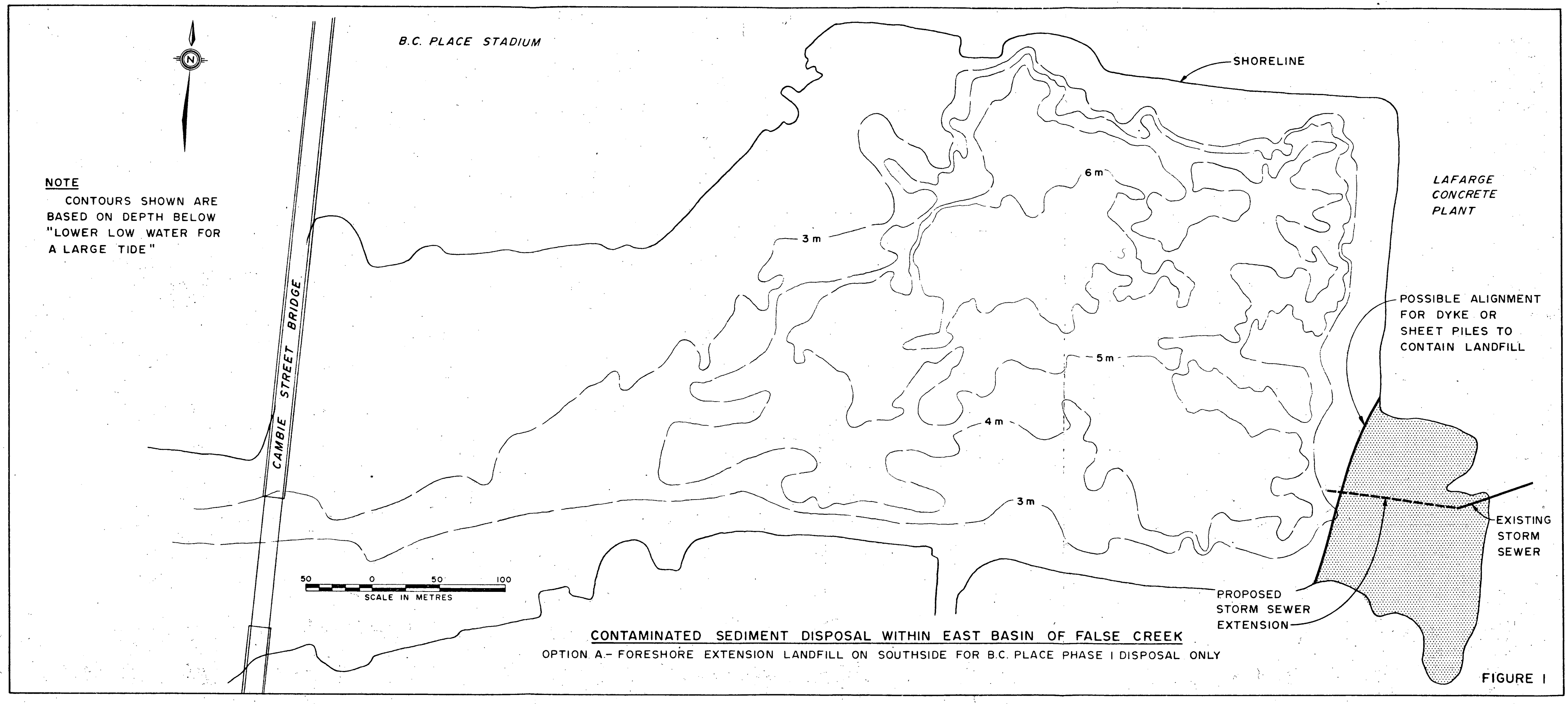
ITEM	DESCRIPTION	ESTIMATE
1.	Suction dredging and conveyance of silts to the East Basin (350,000 cu.m. @$3.75 per cu.m.; plus $150,000 for mobilization/demobilization)	$1,460,000
2.	Construction of gravel retainment dyke and removal of organic silts for the foundation c/w rip-rap armour facing	
	• Dyke, including dredging of foundation (158,000 cu.m. @$15.00 per cu.m.)	2,370,000
	• Rock Armour (7900 cu.m. @$22.00 per cu.m.)	174,000
3.	Soil Bentonite slurry trench cutoff for gravel dyke (5750 sq.m. @$60 per sq.m.)	345,000
5.	Partial dewatering of contaminated silts utilizing sand packed low capacity well points (assumed water discharged to sanitary sewer) (6.25 hectares @$40,000/ha)	250,000
5.	Impervious cover, soil and grass over completed disposal area (6.25 hectares $60,000/ha)	375,000
	Direct Construction Costs	$4,974,000
	Contingencies and Engineering @20%	995,000
	TOTAL CONSTRUCTION COST	$5,969,000*

*say 6.0 million

TABLE 7: CONSTRUCTION COST ESTIMATE FOR OPTION D
SUB-TIDAL FILLING OF EAST BASIN FOR TOTAL B. C. PLACE SEDIMENT DISPOSAL (i.e. 350,000 cu.m.)

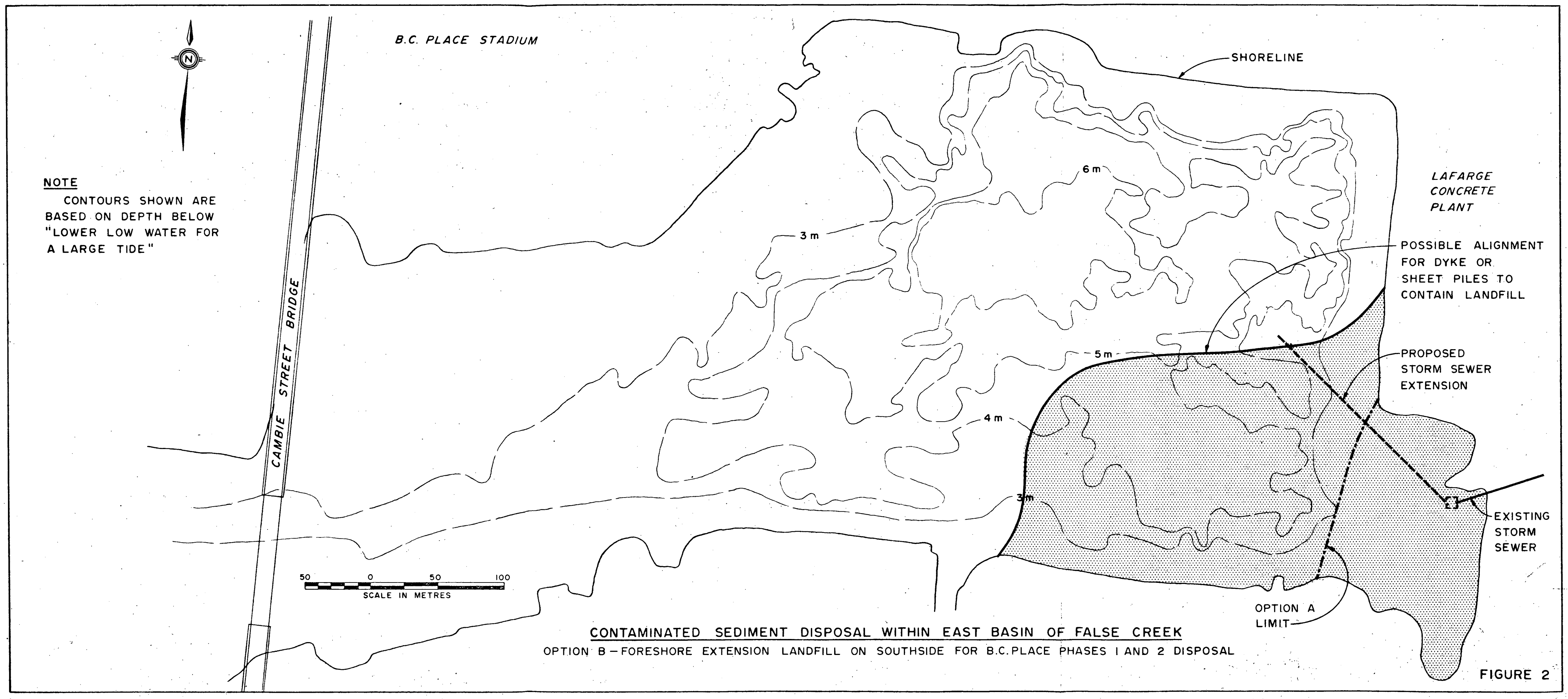
ITEM	DESCRIPTION	ESTIMATE
1.	Suction dredging and conveyance of silts to the East Basin for sub-tidal deposition (350,000 cu.m. @$3.75 per cu.m.; plus $150,000 for mobilization/demobilization)	$1,460,000
2.	Construction of gravel sill c/w Armorflex precast concrete mats; includes dredging of organic silts below dyke	380,000
	Direct Construction Costs	$1,840,000
	Contingencies and Engineering @20%	368,000
	TOTAL CONSTRUCTION COST	$2,208,000*

*say 2.2 million



CONTAMINATED SEDIMENT DISPOSAL WITHIN EAST BASIN OF FALSE CREEK

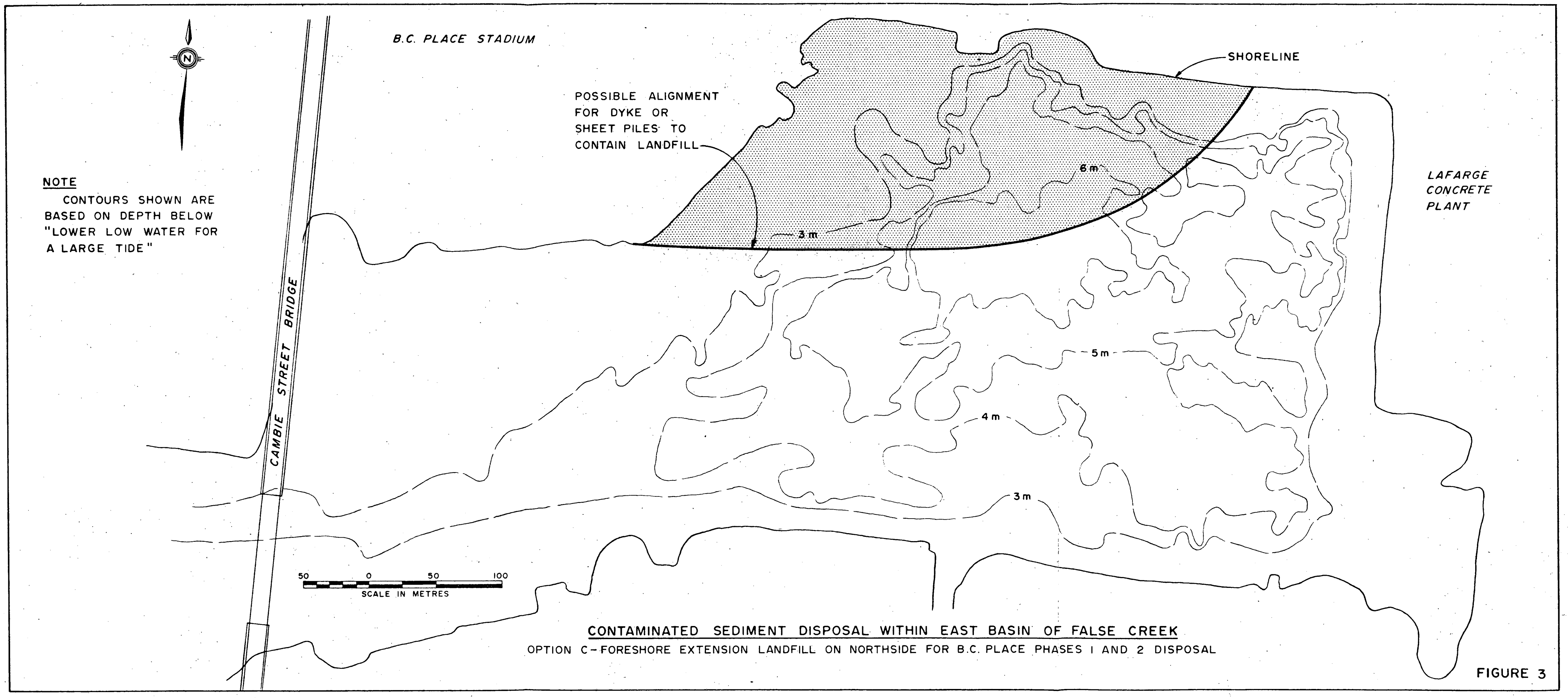
OPTION A.- FORESHORE EXTENSION LANDFILL ON SOUTHSIDE FOR B.C. PLACE PHASE I DISPOSAL ONLY



CONTAMINATED SEDIMENT DISPOSAL WITHIN EAST BASIN OF FALSE CREEK

OPTION B – FORESHORE EXTENSION LANDFILL ON SOUTHSIDE FOR B.C. PLACE PHASES I AND 2 DISPOSAL

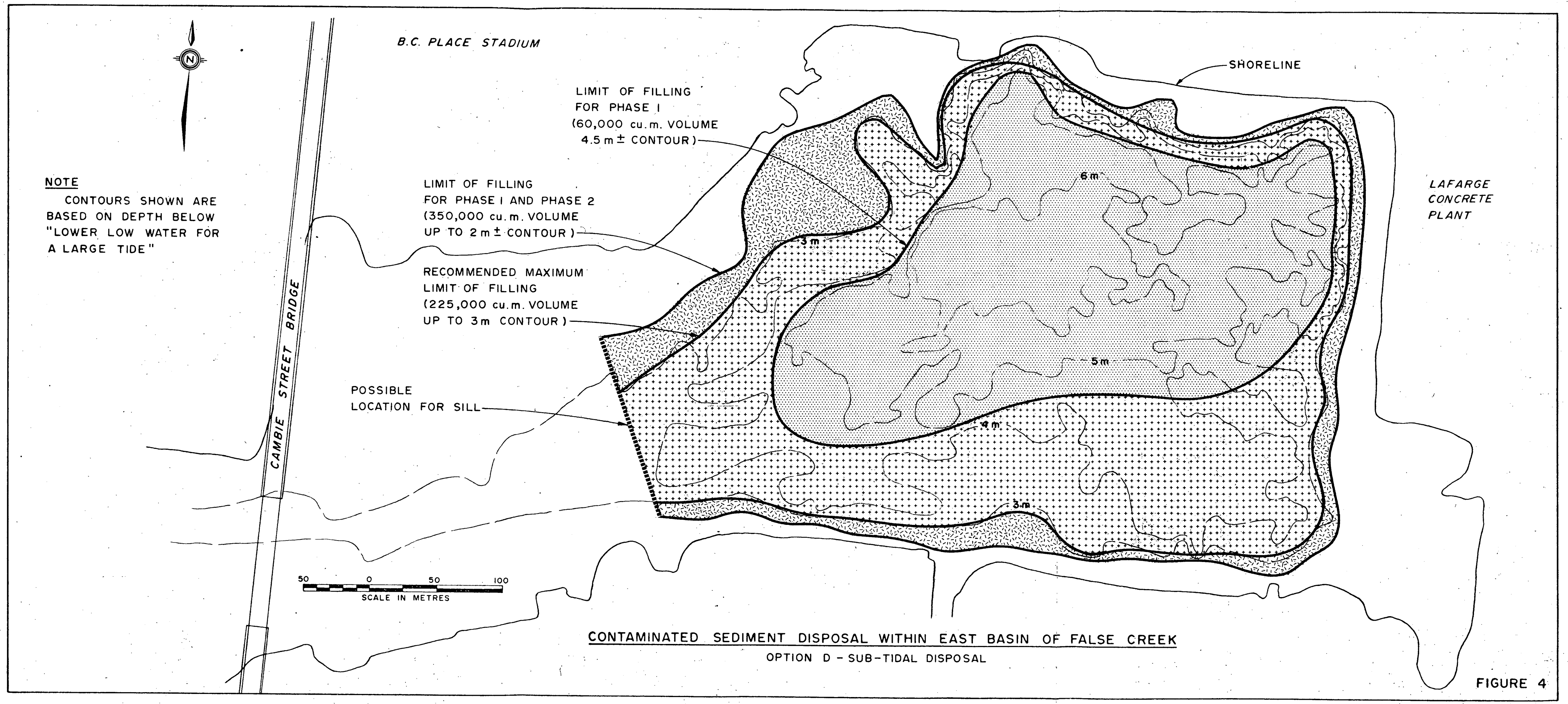
FIGURE 2



CONTAMINATED SEDIMENT DISPOSAL WITHIN EAST BASIN OF FALSE CREEK

OPTION C – FORESHORE EXTENSION LANDFILL ON NORTHSIDE FOR B.C. PLACE PHASES 1 AND 2 DISPOSAL

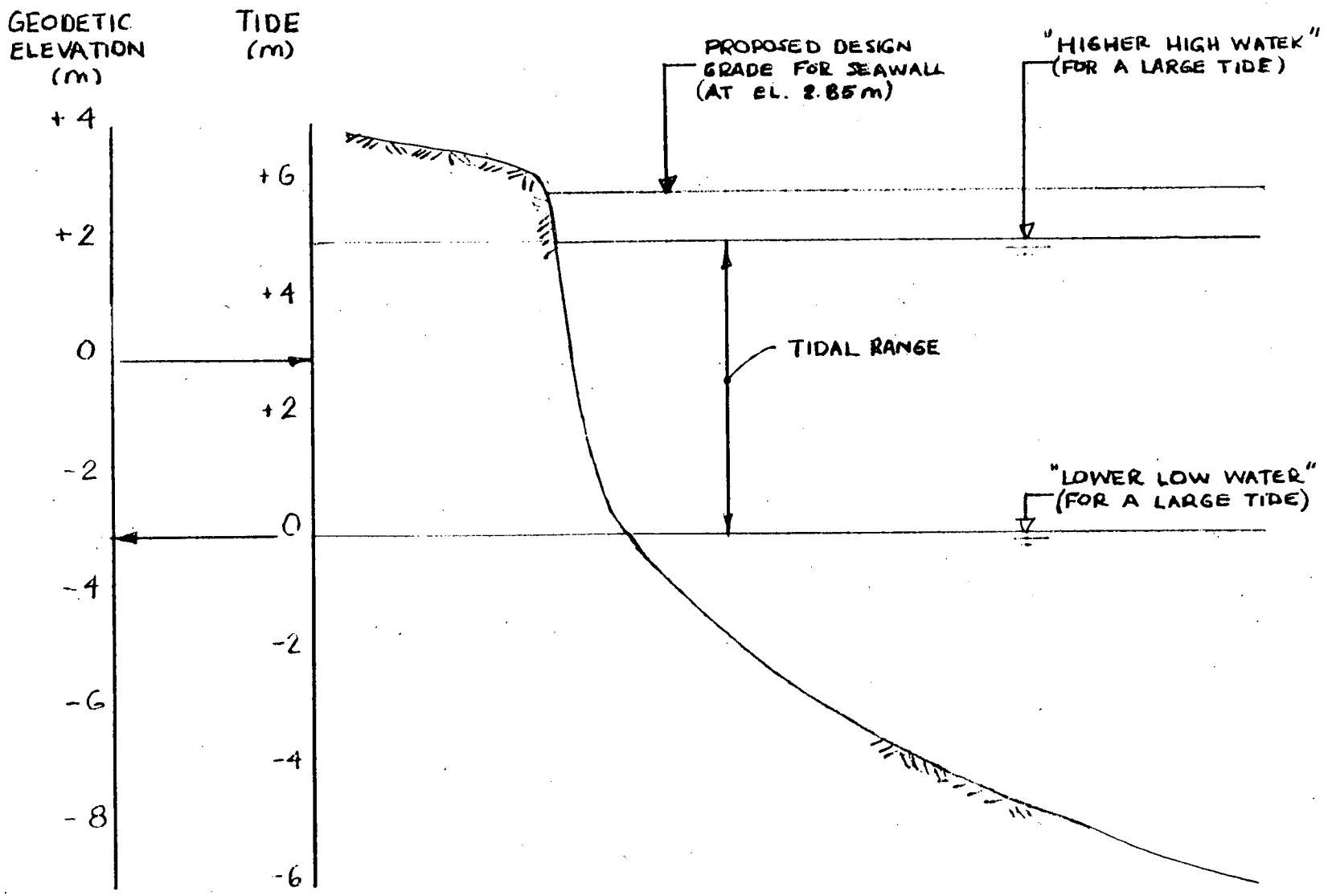
FIGURE 3



CONTAMINATED SEDIMENT DISPOSAL WITHIN EAST BASIN OF FALSE CREEK

OPTION D - SUB-TIDAL DISPOSAL

FIGURE 4



TIDAL RELATIONSHIPS

FIGURE 5